Stress Psychophysiology

Abdul-Monaf Al-Jadiry, MD; FRCPsych
Professor of Psychiatry
Stress

- **Stress** is anything that poses a challenge or a threat to our well-being.
- The term originally was used in **physics** to refer to the internal distribution of a force exerted on a material body, resulting in **strain**.
- In the 1920s and 1930s, the term was used to refer to a **mental strain**, that could cause illness.
- Environmental factors, internal or external stimuli, continually disrupt homeostasis (**internal body environment equilibrium or steady state**), and can be interpreted as **stress**.
Stress

• Selye in 1975 divided stress into:
  - **Eustress**
  - **distress**.¹

• Where stress enhances function (physical or mental, such as through **strength training**, is called **Eustress**.

• Persistent stress that is not resolved through coping or adaptation, deemed **Distress**.

• The factor that provokes **distress** is called **Stressor**.
Body Responses to Stress

• Stress, physiologically, represents a wide range of physical responses that occur as a direct effect of a stressor causing an upset in the homeostasis of the body.
• The body responds by stimulating the nervous, the endocrine, and immune systems resulting in a number of physical changes that have both short and long term effects on the body.
Nervous System Responses

- Stress stimulates the sensory nervous system.
- Then the signal reaches the autonomic nervous system (ANS).
- Activation of the ANS immediately triggers a series of involuntary chemical responses throughout the body.
- Preganglionic neurons release acetylcholine (ACh).
- ACh stimulates postganglionic neurons which release noradrenaline.
- The noradrenaline circulates into the bloodstream activating the body's nervous and endocrine systems.
Central Nervous System (CNS)

• The **brain** processes stress in three main areas: **amygdala**, **hippocampus**, and **prefrontal cortex**.

• These areas packed with stress **corticosteroid** receptors (glucocorticoid and mineralcorticoid) with high affinity for **cortisol**.

• Stimulation of these receptors in the above structures triggers a **fight-or-flight response**.
Central nervous system (CNS)

- If the stress response continues and becomes chronic, activity of the neurons begins to cause:
  - Physical brain damage
  - Mental health changes
  - Decline in neuroplasticity

- To maintain homeostasis the brain is continuously forming new neural connections, reorganizing its neural pathways, and working to fix damages caused by injury and disease. This keeps the brain vital and able to perform cognitive complex thinking.
Endocrine system

• When a stressor acts upon the body, the autonomic nervous system will release the neurotransmitter nor-adrenaline.

• Nor-adrenaline stimulates the hypothalamic-pituitary-adrenal axis (HPA).

• This quickly signals the pituitary gland and finally triggers the adrenal cortex.

• The adrenal cortex responds by signaling the release of cortisol and corticotropin releasing hormone (CRH) directly into the bloodstream.
HPA Axis

- Hypothalamus
  - CRH (Corticotropin Releasing Hormone)
  - Negative Feedback
- Anterior Pituitary
  - ACTH (Adrenocorticotropic Hormone)
- Adrenal Cortex
  - CORT

Diagram showing the hypothalamus releasing CRH, which stimulates the anterior pituitary to release ACTH. ACTH then stimulates the adrenal cortex to produce CORT.
Immune system

• The most important aspect of the immune system are: T-cells found in the form of T-helper and T-suppressor cells.

• Cortisol, once released into the bloodstream, immediately begins to cause division of T-Suppressor cells.

• This division increases the number of T-Suppressor cells while at the same time suppressing T-helper cells.

• This reduces immune protection and leaves the body vulnerable to disease and infection.
Autonomic Nervous System Responses

- Increased central nervous system (CNS) activity
- Increased mental activity
- Increased secretion of adrenaline (epinephrine), noradrenalin (norepinephrine) and cortisol into the bloodstream and to every cell in the body
- Increased heart rate
- Increased cardiac output
- Increased blood pressure
- Increased breathing rate
- Bronchial dilation
**Autonomic Nervous System Responses**

- Increased metabolism
- Increased oxygen consumption
- Increased oxygen to the brain
- Blood is shunted away from the digestive tract and directed into the muscles and limbs
- Increased muscle contraction
- Increased blood coagulation (blood clotting ability)
- Increased blood sugar released by the liver to nourish the muscles
- Release of **endorphins** from the **pituitary gland**
Autonomic Nervous System Responses

- Pupils dilate
- Hair stands on its end (piloerection)
- Sweat glands increase secretion
- Constriction of blood vessels, except to muscles
- Digestive system stops metabolizing food normally
- Saliva dries up
- Decreased perception of pain
- Kidneys decrease output
- Bowel and Bladder sphincter close
Homeostasis

• **Homeostasis** is constantly challenged by adverse forces, the *stressors*.

• **Stress** is, thus, defined as a state of threatened homeostasis and is counteracted by a complex a number of physiologic and behavioral responses that reestablish homeostasis (*adaptive stress response*).

• Excessive and/or chronically imposed stressors may have adverse impact on a variety of physiologic functions, such as growth, reproduction, metabolism and the immuno-competence, as well as on personality development and behavior.
Adaptation to Stress

- **Behavioral adaptation:** includes increased arousal, alertness, vigilance, and cognition, focused attention, and enhanced analgesia, with concurrent inhibition of vegetative functions, such as feeding and reproduction.

- **Physical adaptation:** oxygen and nutrients are shunted to the central nervous system (CNS) and the stressed body site(s), where they are needed the most.

- The prolongation of the initial adaptive responses may turn maladaptive and contribute to the development of disease.
Stress and the General adaptive syndrome (GAS)

• The process of the body’s struggle to maintain balance is what Selye termed, the *General Adaptation Syndrome*.

• The *General Adaptation syndrome* model was introduced in 1936 by Hans Selye showing in three phases the effects of stress on the body.

• Selye developed the theory that stated “stress is a major cause of disease” because chronic stress causes long-term chemical changes.
General adaptive syndrome (GAS)

- Selye observed that the body would respond to any external biological source of stress with a predictable biological pattern in an attempt to restore the body’s internal homeostasis.

- The initial reaction is hormonal, fight or flight stress response - and its purpose is for handling stress very quickly.

- Pressures, tensions, and other stressors can greatly influence body normal metabolism.

- Selye determined that there is a limited supply of adaptive energy to deal with stress. That amount declines with continuous exposure.
General adaptive syndrome (GAS)

The general adaptation syndrome, has three distinct phases:

1. ALARM STAGE

- The fight or flight response. Activation of the HPA axis, the nervous system and the adrenal glands take place.
- The main stress hormones, cortisol, adrenaline, and noradrenaline, are released to provide instant energy.
- Too much adrenaline results in high blood pressure, leading to heart attack and stroke.
- The excess production of the cortisol can cause damage to cells and muscle tissues leading to cardiovascular conditions, stroke, gastric ulcers, and high blood sugar levels.
General adaptive syndrome (GAS)

2. RESISTANCE STAGE

• Homeostasis begins restoring balance and a period of recovery for repair and renewal takes place.
• Stress hormone levels may return to normal but reduced defenses and adaptive energy may be a result.
• If a stressful condition persists, the body adapts by a continued effort in resistance and remains in a state of arousal.
• Repeating this process too often with little or no recovery ultimately this moves the body into the final stage.
3. EXHAUSTION STAGE

- At this phase, the stress has continued for some time, and body’s ability to resist is lost because its adaptation energy supply is gone.
- Often referred to as overload, burnout, adrenal fatigue, maladaptation or dysfunction – Here is where stress levels go up and stay up!
- This stage of the general adaptation syndrome is the most hazardous to health.
General adaptive syndrome (GAS)

EXHAUSTION STAGE

• Chronic stress can damage nerve cells in tissues and organs.
• Particularly vulnerable is the hippocampus section of the brain.
• Thinking and memory are likely to become impaired, with tendency toward anxiety and depression.
• There can also be adverse function of the autonomic nervous system that contributes to high blood pressure, heart disease, rheumatoid arthritis, and other stress related illness.
Stress Symptoms

Symptoms of stress may be:

• cognitive,
• emotional,
• physical,
• behavioral.
Stress Symptoms

• *Cognitive symptoms*
  - Memory problems
  - Inability to concentrate
  - Poor judgment
  - Pessimistic approach or thoughts
  - Anxious or racing thoughts
  - Constant worrying
Stress Symptoms

• *Emotional symptoms*
  - Moodiness
  - Irritability or short temper
  - Agitation, inability to relax
  - Feeling overwhelmed
  - Sense of loneliness and isolation
  - Depression or general unhappiness
Stress Symptoms

- Physical symptoms
  - Aches and pains
  - Diarrhea or constipation
  - Nausea, dizziness
  - Chest pain, rapid heartbeat
  - Loss of sex drive
  - Frequent colds
Stress Symptoms

• *Behavioral symptoms*

  - Eating more or less
  - Sleeping too much or too little
  - Isolating oneself from others
  - Neglecting responsibilities
  - Using alcohol, cigarettes, or drugs to relax
  - Nervous habits (e.g. nail biting, pacing)
Stress Disorders

• Disorders which usually develop as a result of a terribly frightening, life-threatening, or otherwise highly unsafe experience.

- Acute Stress Disorder
- Posttraumatic Stress Disorder
Stress Management

• **Stress management**

• encompasses techniques intended to equip a person with effective coping mechanisms for dealing with psychological stress.

• Stress-management techniques include:
  - relaxation techniques
  - time-management skills
  - counseling
  - group therapy
  - exercise
  - maintaining an overall healthy lifestyle.
Stress Management

• Ways of coping with stress include:
  ➢ Controlling the source of stress
  ➢ Learning to set limits and to say "no" to some of the demands
  ➢ A person's capacity to tolerate the source of stress may be increased by thinking about another topic such as a hobby, listening to music
Thank You